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# Life Cycle Cost Estimating Factors for Cybersecurity in Federal IT Systems

**2021 Joint SW & IT Cost Forum**

**September 16, 2021**

**Estimate with Confidence™**

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# Today's Presenter

## Richard Mabe, PRICE Systems, LLC Solutions Consultant



- Over 45 years of operations analysis experience
  - Air Force Officer; Civil service employee (Retired); Federal contractor
  - Specializing in logistics analysis and cost analysis for US government programs
- Applies industry best-practices to estimate life cycle costs for Software and IT systems
- Experience includes hands-on data collection, cost estimating, and project management
- Holds a BS Degree in Geology from Boise State University and an MS in Logistics Management from AFIT

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# Overview



- Background
- Scope
- Research Database
- Analysis Approach
- Current Results and Conclusions\*

**\* Work in progress. Factors still evolving.**

# Background

- PRICE Systems and the MITRE Corporation jointly researched cybersecurity costs in 2019
  - PRICE researched factors to estimate cybersecurity costs in a general IT system
  - MITRE described analogous costs for IT systems focused only on cybersecurity
  - Presented results to the 2020 Joint SW & IT Cost Forum
  - Presented updated results to the 2021 ICEAA Workshop and a PRICE Webinar
- Peer reviews identified several areas requiring further research
  - Add sustainment costs/factors
  - Add DOD programs to the database
  - Conduct statistical validation/testing to prove the factors are useful
  - Also evaluate the factors with outliers removed from the database

# Scope

- This report provides an update on just the cost factors researched by PRICE
  - Methods to estimate the cost of cybersecurity in a general IT system
  - Open-source Cost, Budget and Technical data\*
  - Cybersecurity cost categories informed by Mil-Std-881E, Appendix J (IT System Work Breakdown Structure for the DOD)
  - Normalized factors across federal agencies and programs

**\*Unable to identify and incorporate open-source technical data; e.g, number of controls; HW or SW sizing; integration complexities**

# Poll

- How much experience have you had with Cybersecurity programs or methods?
  - a. 5+ Years
  - b. 3 to 4 Years
  - c. 1 to 2 Years
  - d. None



# Research Database

## Data Source: OMB IT Dashboard\*

- First launched June 1, 2009
- Allows Federal agencies and the public to view details of Federal information technology (IT) investments online and track their progress over time
- Includes data received from agency IT Portfolios and Business Case reports
- Agency Chief Information Officers (CIO) are responsible for evaluating and updating their data on a regular basis

\* <https://www.itdashboard.gov/drupal/data/datafeeds>



- Extracted 31,358 IT Activities from the web site with associated Program Level budgets (Activity Report; Portfolio Report)
- Selected 2,473 cybersecurity related Activities for the analysis
  - Represent 237 IT Programs across 25 Executive Agencies
  - Used a structured keyword search to identify the cyber related activities; keywords included (acronym definitions in back-up):

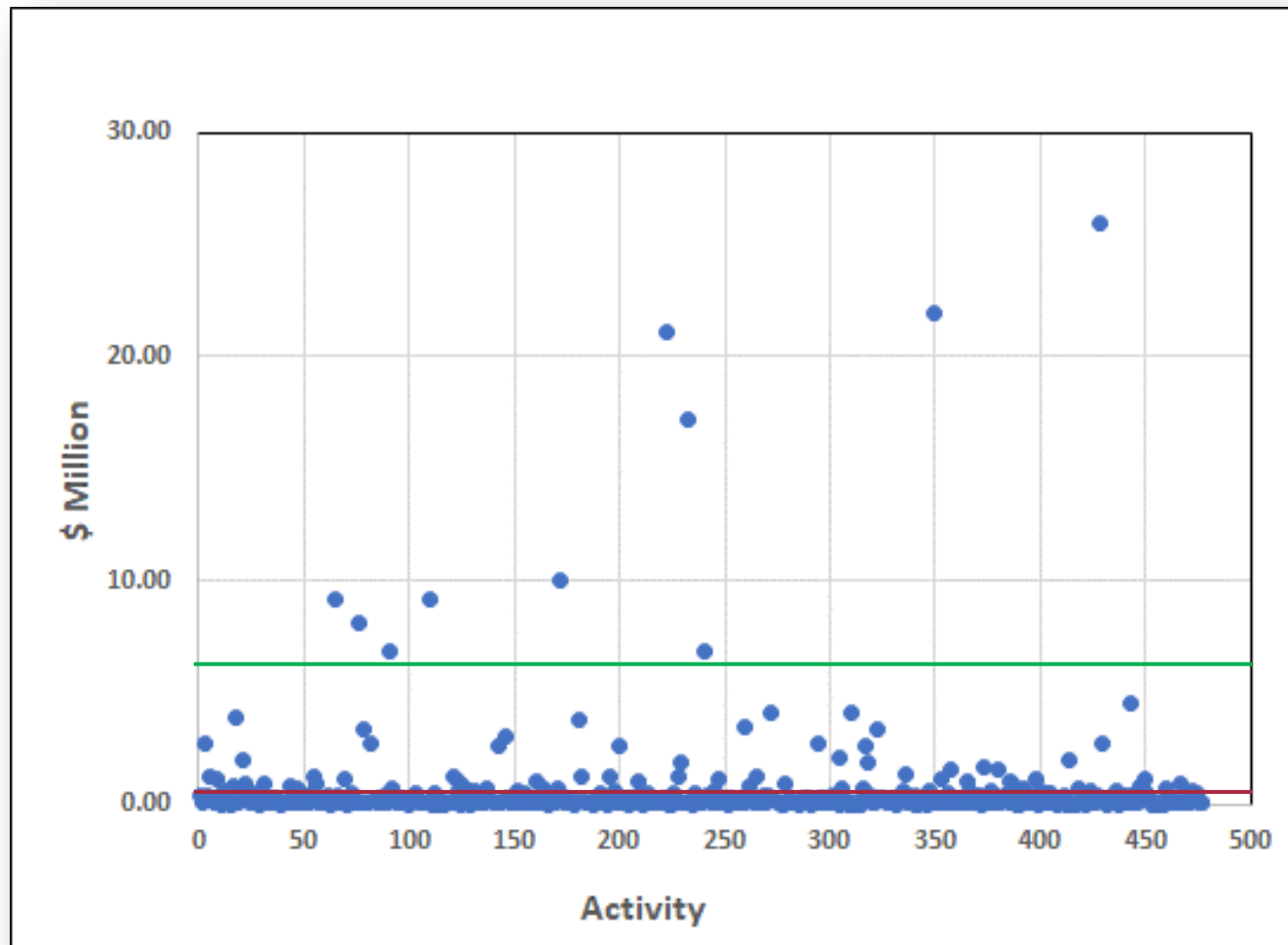
<i>cyber</i>	<i>incident</i>	<i>NIST</i>	<i>DIACAP</i>
<i>security</i>	<i>authorization</i>	<i>integrity</i>	<i>assessment</i>
<i>penetration</i>	<i>C&amp;A</i>	<i>RMF</i>	<i>ATO</i>
<i>vulnerability</i>	<i>monitoring</i>	<i>risk</i>	<i>STIG</i>
<i>certification</i>	<i>controls</i>	<i>assurance</i>	<i>remediation</i>
- Finally, removed activities that were not actually cyber, or that had both cyber and non-cyber effort
  - Included duplicate activities and activities with zero activity cost

# Final Activity Count

- 772 Cyber only Activities, across 181 IT Programs in 23 Executive Agencies\*
  - DOD programs fell out during the filtering process
  - But only initially included OSD level programs (no service level)
- Separated out 10% of the Activities to use for subsequent test and validation
  - Not part of the database used to develop the factors
  - 50 Dev activities + 20 O&S activities

**\* Most DOD IT programs in the OMB database had not yet reported cybersecurity activities in their postings to the OMB Dashboard**

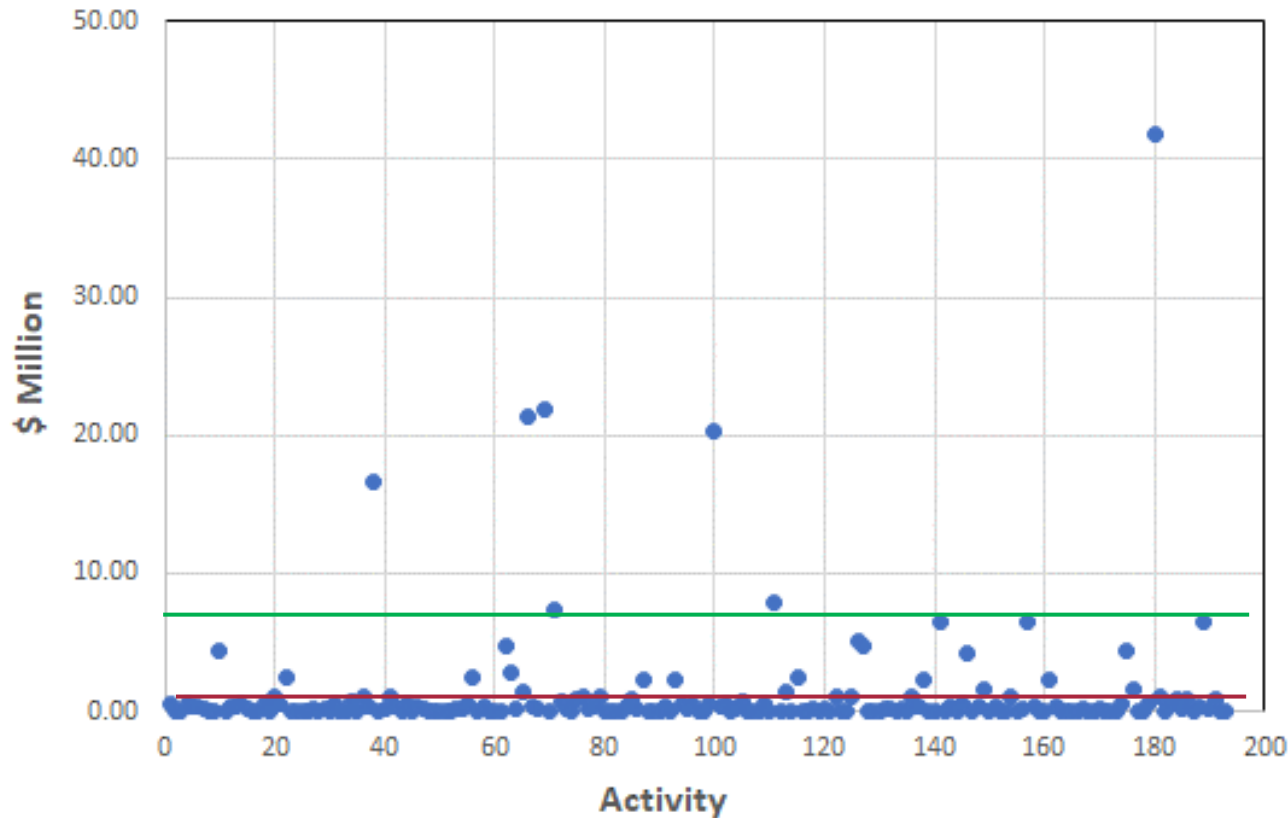
# Development Activity Costs



Total Spending (\$ M)	
Mean	0.637
Standard Error	0.102
Median	0.129
Mode	0.075
Standard Deviation	2.235
Sample Variance	4.995

**Outliers potentially equal any value > \$6.0M (> 3.0 Std Dev from Mean)**

# O&S Activity Costs



Total Spending (\$ Million)	
Mean	1.2858
Standard Error	0.3074
Median	0.1581
Mode	0.0160
Standard Deviation	4.2710
Sample Variance	18.2418

**Outliers potentially equal any value > \$8.0M**



# Analysis Approach

- Checked for correlation of Activity costs within agencies or between agencies
  - No significant correlation identified
  - Spending for cybersecurity activities varied widely by Executive Agency, IT Program, and Activity
  - Cybersecurity pending appeared to be random (unique per individual program)
- Evaluated data to identify Benchmarks or Factors to use for estimating
  - Cyber Factor:  $\text{Cyber \$} = X\% \text{ of other Program Expenditures}$
- Benchmarks/Factors organized by Cyber Cost Category

# Cyber Cost Categories

- Divided the Development Phase Activities into the following Cost Categories:

Management	Requirements/Risk	HW/SW
Cyber Program Management	Authentication/Certification	SW Application Release
Contractor Support	Architecture/Design	Cyber HW Procure
Cyber Testing	Cyber Requirements Analysis	
Cyber Documentation	Assess Risk/Identify Controls	
Cyber Training	Assess Security (General)	

- Based on a narrative description for each activity
- **Subjective assessment by research analyst**; not official designations in the database
- Informed by Mil-Std-881E, Appendix K (Common Elements)

# Cyber Cost Categories

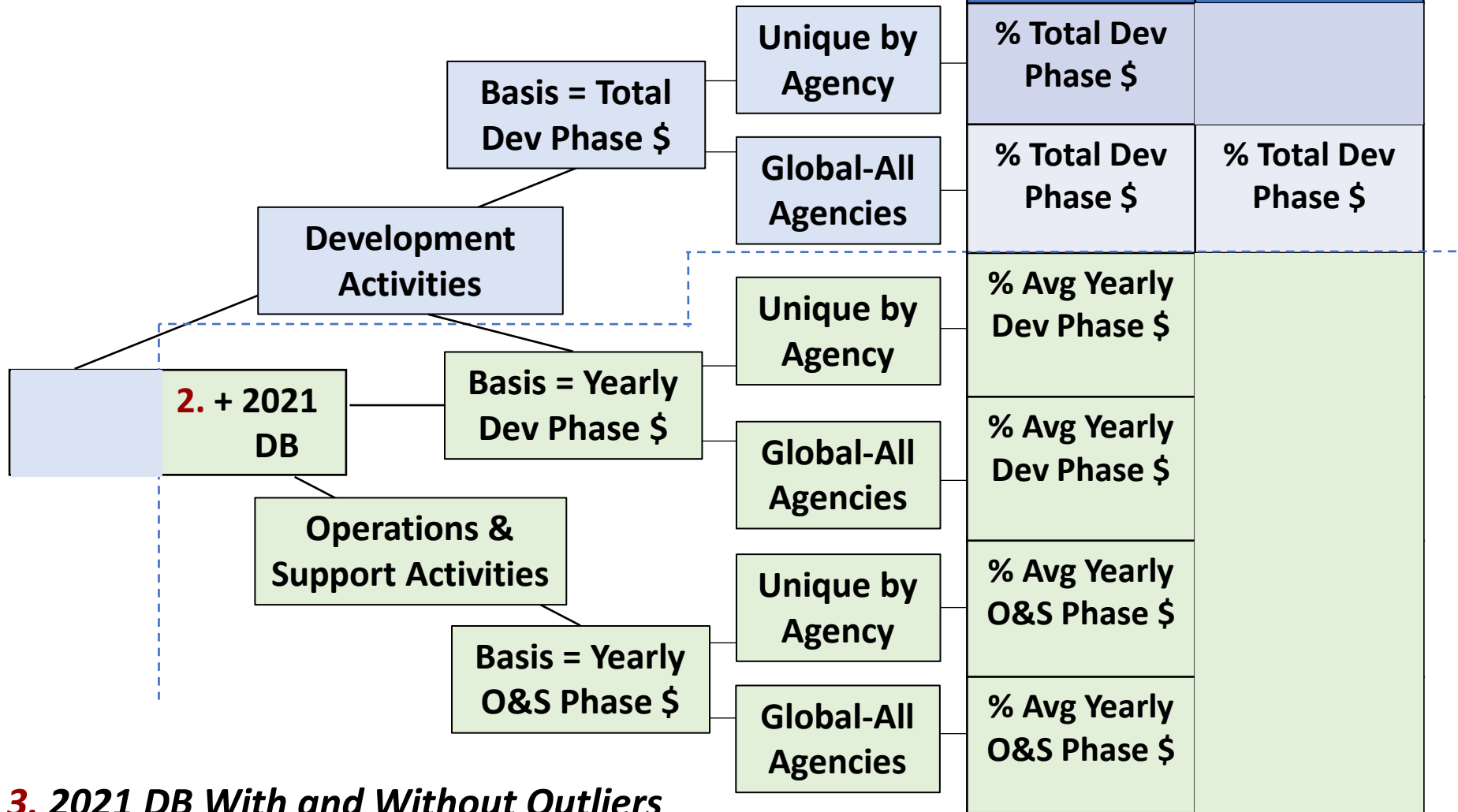
- Divided the Operations and Support Phase Activities into the following Cost Categories:

Management	Requirements/Risk	HW/SW
Manage Cyber Operations	Authentication/Certification	SW Maintenance Release
Contractor Cyber Support	Monitor System/Maintain Controls	SW Security Patch / IAVA
		Maintain Cyber HW
		Cloud Costs/Fees

- Based on a narrative description for each activity
- **Subjective assessment by research analyst;** not official designations in the database
- Informed by Mil-Std-881E, Appendix J (IT Systems O&S)



# Develop Benchmarks/Factors: Experimental Design (3 Steps)



## 3. 2021 DB With and Without Outliers

# Creating Data Factors (Approach 1)

- Sort by Agency, IT System and Cyber Cost Category:
  - Cyber Activity Cost as a % of Total Development Cost for the Program

Agency	Investment Title (System) and Indentured Cyber Activity	2009	2010	2011	2012	2013	2014	2015	2016	Total
Department of XXXXX	IT System 1 Total Annual Cost (TY, \$M)				\$ 2.57	\$ 53.17	\$ 0.92			\$ 56.66
	% Cyber Documentation					\$ 0.27				0.473%
Department of XXXXX	IT System 2 Total Annual Cost		\$ 23.48	\$ 30.93	\$ 24.10	\$ 25.00	\$ 1.41			\$ 104.93
	Cyber Testing				\$ 0.33					0.310%
	% Cyber Documentation			\$ 0.08						0.078%
Department of XXXXX	IT System 3 Total Annual Cost				\$ 0.71	\$ 0.85	\$ 9.56	\$ 4.60		\$ 15.72
	% Assess Risk/Controls						\$ 1.60			10.179%
	% Assess Risk/Controls						\$ 0.24			1.533%

*1 Fed Agency*

*3 IT Programs  
At least 1 Cyber  
activity per Program*

*Program Budget per Year (\$M)  
Cyber Activity \$ Spent per Year (\$M)*

*Cyber \$  
Spent as %  
of Total  
Budget*

# Creating Data Factors (Approach 2)

- Sort by Agency, IT System and Cyber Cost Category:
  - Cyber Category Cost per Year as a % of the Budget in each Year
  - Used to develop O&S factors and as alternate for Dev factors

Agency	Investment Title (System) and Indentured Cyber Activity	2009	2010	2011	2012	2013	2014	2015	2016	Total
Department of XXXXX	IT System 1 Total Annual Cost (TY, \$M)				\$ 2.57	\$ 53.17	\$ 0.92	\$ -	\$ -	\$ 56.66
	% Cyber Documentation					0.50%				
Department of XXXXX	IT System 2 Total Annual Cost		\$ 23.48	\$ 30.93	\$ 24.10	\$ 25.00	\$ 1.41	\$ -	\$ -	\$ 104.93
	Cyber Testing				1.35%					
	% Cyber Documentation			0.27%						
Department of XXXXX	IT System 3 Total Annual Cost				\$ 0.71	\$ 0.85	\$ 9.56	\$ 4.60	\$ -	\$ 15.72
	% Assess Risk/Controls						16.73%			
	% Assess Risk/Controls						2.52%			

*1 Fed Agency*

*3 IT Programs  
At least 1 Cyber  
activity per Program*

*Program Budget per Year (\$M)  
Cyber Activity \$ Spent per Year (\$M)  
Cyber \$ Spent as % of Budget in Year Spent*

# Roll-Up by Category by Agency

- Result: Fed Agency specific Cyber Category Cost factors
- Average and Median value by Cyber Category Cost for each Agency

Agency	Cyber Factor	Cost Category	Mean by Activity	Median by Activity	High	Low
Department of XXXX	0.024%	Authentication/ Certification	0.04%	0.02%	0.064%	0.024%
Department of XXXX	0.040%	Authentication/ Certification				
Department of XXXX	0.024%	Authentication/ Certification				
Department of XXXX	0.064%	Authentication/ Certification				
Department of XXXX	0.024%	Authentication/ Certification				
Department of XXXX	0.046%	Cyber Testing	0.14%	0.14%	0.228%	0.046%
Department of XXXX	0.228%	Cyber Testing				
Department of XXXX	0.175%	Manage Cyber Program	0.58%	0.58%	0.994%	0.175%
Department of XXXX	0.994%	Manage Cyber Program				
Department of XXXX	0.011%	SW App Release	0.01%	0.01%	0.01%	0.01%

*1 Federal Agency      % of Total Budget by Activity by Category*

*Summary by Category for the Agency*

# Roll-Up by Category across All Agencies

- Result: A universal set of Cyber Category Cost factors for All agencies
- Average and Median value by Cyber Category Cost

Cyber Category	Average by Category (All Agencies)	Median by Category (All Agencies)	High by Category (All Agencies)	Low by Category (All Agencies)
Cyber Progr Management	0.88%	0.27%	5.099%	0.000%
Authentication/ Certification	5.00%	0.17%	16.284%	0.010%
Cyber Documentation	0.34%	0.10%	5.819%	0.000%
Cyber Testing	0.86%	0.23%	14.000%	0.004%
Assess Risk/Identify Controls	0.76%	0.23%	10.179%	0.000%
SW App Release	1.93%	0.99%	15.798%	0.017%
Assess Security (General)	0.93%	0.35%	5.487%	0.003%
Cyber Req'ts Analysis	0.39%	0.13%	5.012%	0.026%
Architecture/Design	1.87%	0.08%	10.586%	0.022%
Contractor Support	11.11%	0.84%	56.519%	0.009%
Cyber Training	7.74%	2.60%	29.223%	0.023%
Cyber HW Procure	5.96%	0.92%	21.619%	0.011%
Cloud Costs/Fees	0.29%	0.29%	0.287%	0.287%



# Summary Analysis, Results and Conclusions

# Analysis

- Applied the factors to 50 Development Activities and 20 O&S Activities drawn from the original database
  - The withheld Activities were not used to develop the factors
- Evaluated comparison metrics that described the difference between the actual cost distribution and the estimated cost distribution for the 50 activities
  - Pearson's Correlation Coefficient (R)
  - F-statistic to compare variance
  - t-Statistic to compare the means
  - Std Error of the Estimate
  - Number of activities Over or Underestimated and % Over or Under
- Drew conclusions from the comparison metrics



# BLUF: Compare Best Fit Global Factors

Best Fit Results	Dev Factor = % Total Dev \$	Dev Factor = % Yrly Dev \$	O&S Factor = % Yrly O&S \$	Notes and Explanations
<b><u>1. Factors from 2019 Research</u></b>	<b>With Outliers</b>	<b>With Outliers</b>	<b>With Outliers</b>	<p>1. “% Total Dev \$” yields a factor that can be applied to actual annual spending for any year in the development phase</p> <p>2. “% Avg Yearly Dev \$” yields a factor that must be applied to the <b>average</b> annual spending across all years of the Development Phase</p> <p>3. O&amp;S factors are only for “% Avg Yearly O&amp;S \$” because O&amp;S funds are only authorized for a single year at a time</p> <p>4. Removing the outliers has the greatest impacts on factors as a “% of Total Dev \$”; only minimal impacts on factors as a “% of Yearly Dev or O&amp;S \$”</p>
Top 6 Average	10.55	N/A	N/A	
Other Category Average	31.16	N/A	N/A	
Top 6 Median	2.79	N/A	N/A	
Other Category Median	17.04	N/A	N/A	
<b><u>2. Updated Factors from 2021</u></b>	<b>With Outliers</b>	<b>With Outliers</b>	<b>With Outliers</b>	
Top 6 Average	9.77	21.18	12.2	
Other Category Average	28.3	28.69	10.78	
Top 6 Median	1.98	9.27	5.64	
Other Category Median	5.19	12.17	9.29	
<b><u>3. Updates from 2021</u></b>	<b>No Outliers</b>	<b>No Outliers</b>	<b>No Outliers</b>	
Top 6 Average	5.3	22.75	9.96	
Other Category Average	12.96	18.51	10.78	
Top 6 Median	1.96	6.23	5.52	
Other Category Median	3.88	10.49	9.29	





# Detailed Analysis, Results and Conclusions\*

\* Present as Time Allows  
Also check Back-Up Slides

# Estimating Cyber Costs per Activity



- **Estimated cyber costs as a % of Total Phase Cost:**
  - **Cost 1** = **Average** Factor (Average % of Total Dev \$ by Category) x Total Spent for the Parent IT System in all Dev Years
  - **Cost 2** = **Median** Factor (Median % of Total Dev \$ by Category) x Total Spent for the Parent IT System in all Dev Years
  - **Dev factors only**; O&S cost factors not determined as a % of Total O&S Phase costs
- **Estimated cyber cost as a % of Annual Spending by Phase:**
  - **Cost 3** = **Average** Factor (Average % of Avg Yearly \$ by Category) x Number of Funded Years for the Activity being Estimated x **Average Expenditures per Year by Phase** for the Parent IT System
  - **Cost 4** = **Median** Factor (Median % of Avg Yearly \$ by Category) x Number of Funded Years for the Activity being Estimated x **Average Expenditures per Year by Phase** for the Parent IT System
  - **Dev and O&S cost factors**

## Results: With the Outliers

- Includes Tables of Global Factors by Category across All Agencies
- Contact [richard.mabe@pricesystems.com](mailto:richard.mabe@pricesystems.com) for a worksheet with Tables of Specific Factors by Category by Agency

# Summary: Best Fit Metrics (with the Outliers)

- Based on metrics calculated for each Cost Estimating approach (1 – 4)\*

Measure for Comparison (alpha = 0.05)	Dev Factors per Category per Agency	Dev Factors per Category All Agencies	O&S Factors per Category per Agency	O&S Factors per Category All Agencies
Factor Type	Avg % of Avg Yearly \$	Med % of Avg Yearly \$	Med % of Avg Yearly \$	Avg % of Avg Yearly \$
Pearson's Coefficient	0.6687	0.2273	0.9540	0.5682
P-value for F-Statistic	0.1569	0.0214	0.9211	1.44E-06
P-value for t-Statistic	0.2774	0.6744	0.1272	0.3081
Std Error (\$M)	0.223	0.1397	0.4251	0.1157
Number of Activities Over-Estimated	31	19	7	13
Average % Overestimated	353%	307%	81%	7,045%
Number of Activities Under-Estimated	12	23	9	5
Average % Underestimated	55%	59%	42%	79%

*\*Detailed results for each approach are included in the Back-Up slides*

# Conclusions: Development Factors

- Results Summary:

- Average and Median **factors by Avg Yearly \$** fit better than the Average and Median **factors by Total Dev \$**
  - *Required normalizing Total Costs to be an Average % per Year for factors by FY*
- “By Agency” values are better than the “Global” values representing all agencies
  - *But each agency did not include activities for each cyber category in the DB*

- Recommendation:

- Apply the Global Factors as a ROM for federal IT programs
  - *Apply the “Median % of Avg Yearly Dev \$” factor per Category **every year** for:*

<i>Cyber Program Management</i>	<i>Cyber Testing</i>
<i>Authentication/Certification</i>	<i>Assess Risk/ Identify Controls</i>
<i>Cyber Documentation</i>	<i>SW Application Releases</i>
  - *Apply the Median factors for the remaining categories as an **occasional “spike”** to mitigate risk, but probably not more than once per IT program*

# Global Dev Factors - % Avg Yearly Dev \$

- For the Average Factors
  - 76% of the activities =21.18% of Avg Yearly Dev \$ across 6 categories and 50% of all agencies
  - 24% of the activities =28.69% of Avg Yearly Dev \$ across 7 categories and 22% of all agencies
- For the Median Factors
  - 76% of the activities = 9.27% of Avg Yearly Dev \$ across 6 categories and 50% of all agencies
  - 24% of the activities =12.17% of Avg Yearly Dev \$ across 7 categories and 22% of all agencies

Cyber Category	Count by Category All Activities	% of Count	Agencies Represented	% of Agencies	Average by Category (All Agencies)	Median by Category (All Agencies)	High by Category (All Agencies)	Low by Category (All Agencies)
Cyber Progr Management	83	17.33%	14	60.9%	4.88%	1.69%	43.457%	0.003%
Authentication/ Certification	75	15.66%	13	56.5%	2.12%	0.82%	39.253%	0.011%
Cyber Documentation	55	11.48%	11	47.8%	1.37%	0.33%	14.892%	0.032%
Cyber Testing	55	11.48%	10	43.5%	3.38%	1.19%	70.211%	0.004%
Assess Risk/Identify Controls	52	10.86%	9	39.1%	2.63%	1.00%	52.900%	0.008%
SW App Release	45	9.39%	12	52.2%	6.80%	4.25%	42.276%	0.017%
Assess Security (General)	31	6.47%	9	39.1%	2.57%	1.36%	12.709%	0.003%
Cyber Req'ts Analysis	26	5.43%	6	26.1%	1.98%	1.17%	12.717%	0.031%
Architecture/Design	19	3.97%	6	26.1%	2.47%	0.54%	10.586%	0.135%
Contractor Support	18	3.76%	5	21.7%	7.23%	1.63%	56.519%	0.021%
Cyber Training	11	2.30%	4	17.4%	8.05%	5.98%	29.223%	0.023%
Cyber HW Procure	8	1.67%	5	21.7%	6.09%	1.21%	21.619%	0.011%
Cloud Costs/Fees	1	0.21%	1	4.3%	0.29%	0.29%	0.287%	0.287%

# Conclusions: O&S Factors

- Results Summary:

- Average and Median factors by FY \$ are **equally valid** for Agency Specific values
  - *Required normalizing Total Costs to Average % per Year for factors by FY*
- “By Agency” values are better than the “Global” values representing all agencies;
  - *But data for each agency did not include activities for each cyber category in the DB*

- Recommendation:

- Apply the Global factors as a ROM for federal IT programs
  - *Apply the “Average % of Avg Yearly O&S \$” factor per Category **every year** for:*
    - Monitor/Maintain Controls      Security Patch/IAVA, Manage*
    - Manage Cyber Operations      SW Maintenance Release*
  - *Apply the Average factors for the remaining categories as an **occasional “spike”** to mitigate risk, but probably not more than once per IT program*



# Global O&S Factors - % Avg Yearly O&S \$

- For the Average Factors

- 95% of the activities = **12.2% of Avg Yearly O&S Costs** across 4 categories and 43% of all agencies
- 5% of the activities = **10.78% of Avg Yearly O&S Costs** across 4 categories and 7% of all agencies

- For the Median Factors

- 95% of the activities = 5.64% of Avg Yearly O&S Costs across 4 categories and 50% of all agencies
- 5% of the activities = 9.29% of Avg Yearly O&S Costs across 4 categories and 22% of all agencies

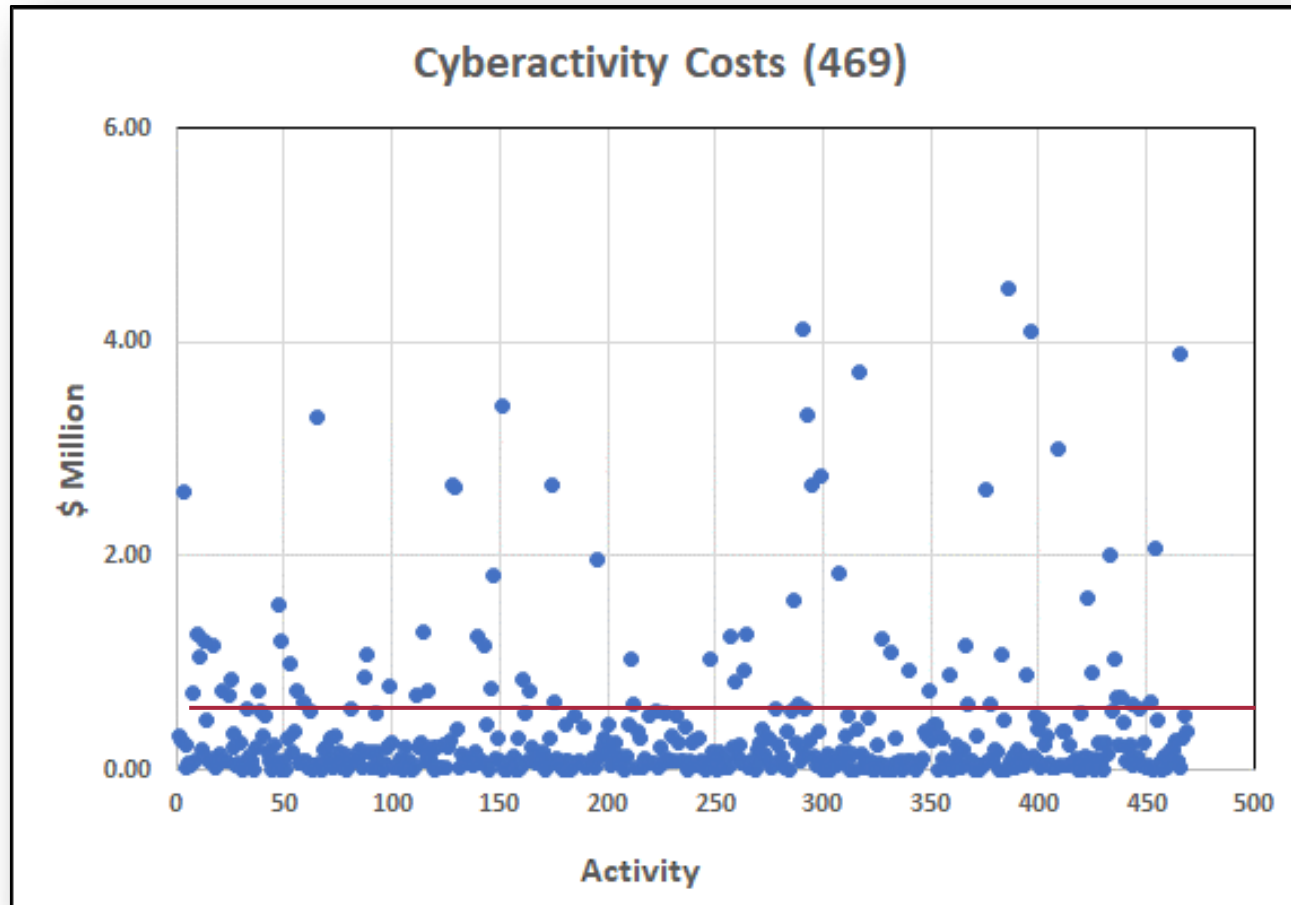
Cyber Category	Count by Category All Activities	% of Count	Agencies Represented	% of Agencies	Average by Category (All Agencies)	Median by Category (All Agencies)	High by Category (All Agencies)	Low by Category (All Agencies)
Monitor System/Maintain Controls	59	30.57%	9	53%	2.2323%	0.2920%	43.8192%	0.0002%
SW Maint Release	55	28.50%	8	47%	5.9767%	4.8641%	33.4190%	0.0114%
Security Patch/IAVA	45	23.32%	6	35%	1.9459%	0.3826%	11.5391%	0.0035%
Manage Cyber Operations	24	12.44%	6	35%	2.0170%	0.1066%	17.3379%	0.0133%
Contractor Cyber Support	4	2.07%	1	6%	5.9303%	4.4403%	14.2106%	0.6299%
Authentication/ Certification	4	2.07%	2	12%	2.0793%	2.0793%	3.7394%	0.4191%
Cloud Costs/Fees	1	0.52%	1	6%	2.2641%	2.2641%	2.2641%	2.2641%
Maintain Cyber HW	1	0.52%	1	6%	0.5069%	0.5069%	0.5069%	0.5069%



## Alternate Results: No Outliers

- Includes Tables of Global Factors by Category across All Agencies
- Contact [richard.mabe@pricesystems.com](mailto:richard.mabe@pricesystems.com) for a worksheet with Tables of Specific Factors by Category by Agency

# Development Activity Costs- No Outliers

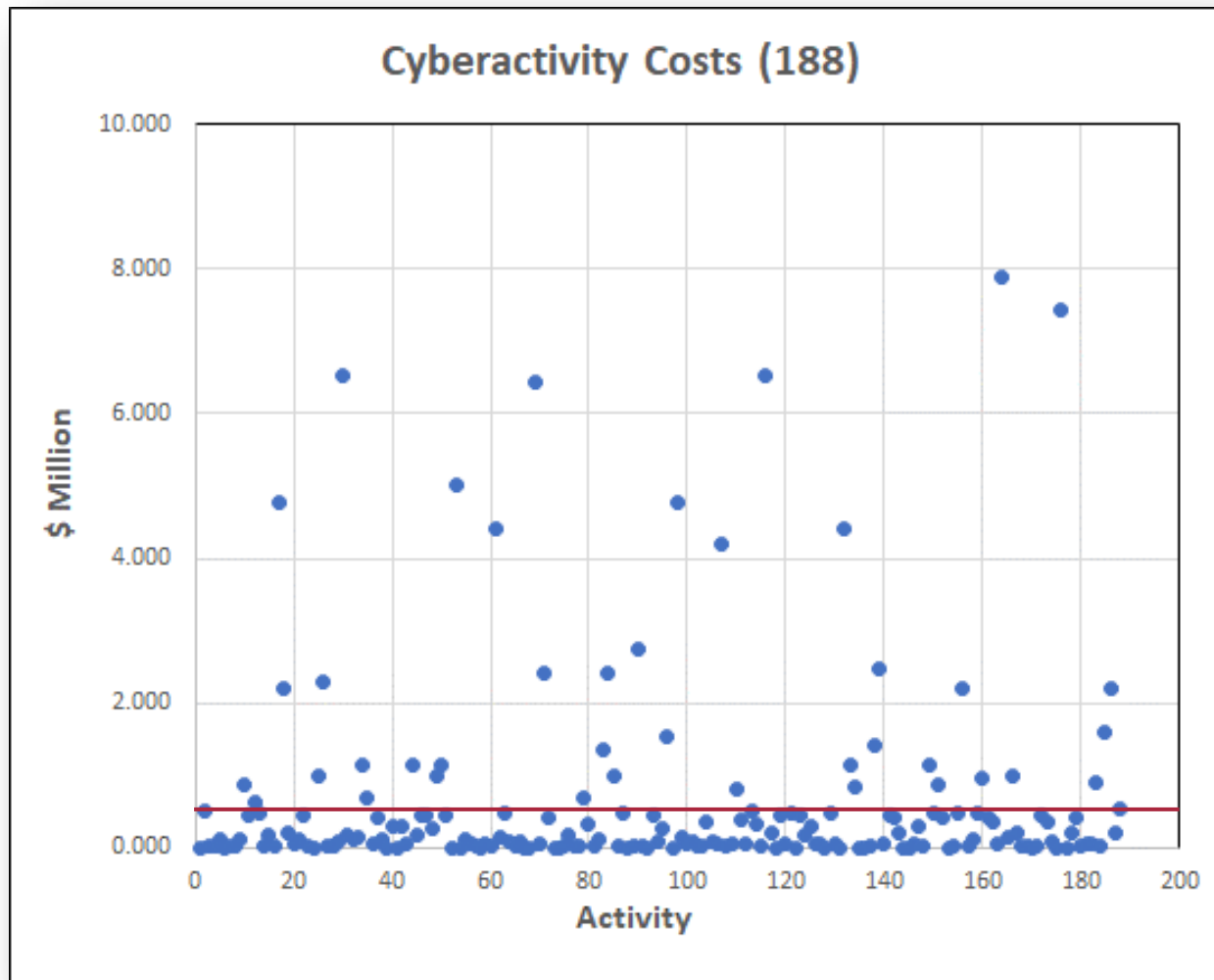


Total Cyber Spending (\$)	
Mean	0.3599
Standard Error	0.0302
Median	0.1200
Mode	0.0750
Standard Deviation	0.6538
Sample Variance	0.4274

Reduced the Mean,  
Std Error and Std  
Deviation

Minimal change to  
the Median and the  
Mode

# O&S Activity Costs – No Outliers



O&M Costs by Activity	
Mean	0.671
Standard Error	0.102
Median	0.138
Mode	0.016
Standard Deviation	1.395
Sample Variance	1.947

Reduced the Mean,  
Std Error and Std  
Deviation

Minimal change to  
the Median and the  
Mode

# Summary: Best Fit (No Outliers)

- Based on metrics calculated for each Cost Estimating approach (1 – 4)\*

Measure for Comparison (alpha = 0.05)	Dev Factors per Category per Agency	Dev Factors per Category All Agencies	O&S Factors per Category per Agency	O&S Factors per Category All Agencies
Factor Type	Med % Tot Dev \$	Med % Tot Dev \$	Med % of Avg Yearly \$	Avg % of Avg Yearly \$
Pearson's Coefficient	<b>0.4939</b>	0.1360	<b>0.9540</b>	<b>0.6936</b>
P-value for F-Statistic	1.253e-09	<b>0.6327</b>	<b>0.9211</b>	5.30e-7
P-value for t-Statistic	<b>0.2298</b>	<b>0.8165</b>	<b>0.1272</b>	<b>0.1728</b>
Std Error (\$M)	0.0801	0.2260	0.4251	0.1083
Number of Activities Over-Estimated	29	22	7	12
Average % Overestimated	104%	333%	81%	6696%
Number of Activities Under-Estimated	19	21	9	6
Average % Underestimated	48%	63%	<b>42%</b>	74%

*\*Detailed results for each approach are included in the Back-Up slides*

# Conclusions: Dev Factors

- Results Summary\* (No Outliers):

- Average and Median **factors by % Total Dev \$** do not fit any better than the Average and Median **factors by % Avg Yearly \$**
  - *With outliers, the Factors by % Avg Yearly \$ were a better fit*
- “By Agency” values are not any **better** than the “Global” values representing all agencies
  - *With outliers, the “By Agency” values were a better fit*
  - *But each Agency did not include activities for each cyber category in the DB*

- Recommendation:

- Apply the Global Factors as a ROM for federal IT programs
  - Apply the “Median % of Total Dev \$” factors per Category **every year** for:

Cyber Program Management	Cyber Testing
Authentication/Certification	Assess Risk/ Identify Controls
Cyber Documentation	SW Application Releases
  - Apply the Median factors for the remaining categories as an **occasional “spike”** to mitigate risk, but probably not more than once per IT program

# Global Dev Factors - % Total Dev \$

- **For the Average Factors** (Lower Avg; Contractor Support no longer a “spike”)
  - **77% of the activities** =5.30% of Total Dev \$ across 6 categories and 50% of all agencies
  - 23% of the activities =12.96% of Total Dev Costs across 7 categories and 22% of all agencies
- **For the Median Factors** (Minimal change to Median; Validates skew in the DB)
  - **76% of the activities** =**1.96% of Total Dev \$** across 6 categories and 50% of all agencies
  - 24% of the activities =**3.88% of Total Dev \$** across 7 categories and 22% of all agencies

Cyber Category	Count by Category All Activities	% of Total Activities	Agencies Represented	% of Agencies	Average by Category (All Agencies)	Median by Category (All Agencies)	High by Category (All Agencies)	Low by Category (All Agencies)
Cyber Progr Management	81	17.27%	14	60.9%	0.87%	0.26%	5.099%	0.000%
Authentication/ Certification	75	15.99%	13	56.5%	0.80%	0.17%	16.284%	0.010%
Cyber Documentation	55	11.73%	11	47.8%	0.34%	0.10%	5.819%	0.000%
Cyber Testing	53	11.30%	10	43.5%	0.60%	0.21%	14.000%	0.004%
Assess Risk/Identify Controls	52	11.09%	9	39.1%	0.76%	0.23%	10.179%	0.000%
SW App Release	45	9.59%	12	52.2%	1.93%	0.99%	15.798%	0.017%
Assess Security (General)	31	6.61%	9	39.1%	0.93%	0.35%	5.487%	0.003%
Cyber Req'ts Analysis	26	5.54%	6	26.1%	0.39%	0.13%	5.012%	0.026%
Architecture/Design	17	3.62%	6	26.1%	0.89%	0.07%	10.586%	0.022%
Contractor Support	16	3.41%	3	13.0%	1.71%	0.23%	8.288%	0.009%
Cyber Training	11	2.35%	4	17.4%	7.74%	2.60%	29.223%	0.023%
Cyber HW Procure	6	1.28%	4	17.4%	0.75%	0.23%	2.291%	0.011%
Cloud Costs/Fees	1	0.21%	1	4.3%	0.29%	0.29%	0.287%	0.287%

# Conclusions: O&S Factors

- Results Summary (No Outliers):

- Average and Median factors by FY are **both valid** for Agency Specific values
  - *Required normalizing Total Costs to Average % Spent per Year for factors by FY*
- “**By Agency**” values are better than the “Global” values representing all agencies;
  - *But data for each agency **did not include activities** for each cyber category in the DB*

- Recommendation:

- Apply the Global factors as a ROM for federal IT programs
  - *Apply the “Average % of Avg Yearly \$” factor per Category **every year** for:*
    - Monitor/Maintain Controls      Security Patch/IAVA, Manage*
    - Manage Cyber Operations      SW Maintenance Release*
  - *Apply the Median or Average factors for the remaining categories as an **occasional “spike”** to mitigate risk, but probably not more than once per IT program*

# Global O&S Factors - % Avg Yearly O&S \$

- For the Average Factors

- 95% of the activities =9.69% of Avg Yearly O&S \$ across 4 categories and 43% of all agencies
- 5% of the activities =10.78% of Avg Yearly O&S \$ across 4 categories and 7% of all agencies

- For the Median Factors

- 95% of the activities =5.52% of Avg Yearly O&S \$ across 4 categories and 50% of all agencies
- 5% of the activities =9.29% of Avg Yearly O&S \$ across 4 categories and 22% of all agencies

Cyber Category	Count by Category All Activities	% of Count	Agencies Represented	% of Agencies	Average by Category (All Agencies)	Median by Category (All Agencies)	High by Category (All Agencies)	Low by Category (All Agencies)
Monitor System/Maintain Controls	59	30.57%	9	53%	2.2323%	0.2920%	43.8192%	0.0002%
SW Maint Release	55	28.50%	8	47%	5.9767%	4.8641%	33.4190%	0.0114%
Security Patch/IAVA	45	23.32%	6	35%	1.9459%	0.3826%	11.5391%	0.0035%
Manage Cyber Operations	24	12.44%	6	35%	2.0170%	0.1066%	17.3379%	0.0133%
Contractor Cyber Support	4	2.07%	1	6%	5.9303%	4.4403%	14.2106%	0.6299%
Authentication/ Certification	4	2.07%	2	12%	2.0793%	2.0793%	3.7394%	0.4191%
Cloud Costs/Fees	1	0.52%	1	6%	2.2641%	2.2641%	2.2641%	2.2641%
Maintain Cyber HW	1	0.52%	1	6%	0.5069%	0.5069%	0.5069%	0.5069%





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# Back-up Slides

# Key Word Definitions

*NIST – National Institute of Standards and Technology*

*DIACAP – DOD Information Assurance Certification and Accreditation Process*

*C&A – Certification and Authorization*

*RMF – Risk Management Framework (Replaced DIACAP)*

*ATO – Authority to Operate*

*STIG – Security Technical Implementation Guides*

# Limitations on the Final Data

- Costs not identified by budget appropriation or by Labor Category
- Unable to identify split between contract labor and government employees
- Assumed all funds were “As Spent” (current year); did not normalize to a Base Year (constant year)
  - Too many agencies
  - No set of common adjustment factors to apply
- Representative sample only
  - May be additional keywords or activities not included

# Agencies Included in the Analysis

- DoD only included as O&S activities
  - Only OSD Level systems in the OMB DB
  - Dev activities were excluded by the filters used
- All agencies do not include all cyber cost categories
  - But each agency shown here includes at least 1 cyber activity

Development Cyber Activities by Agency
Department of Agriculture
Department of Commerce
Department of Education
Department of Energy
Department of Health and Human Services
Department of Homeland Security
Department of Justice
Department of Labor
Department of State
Department of the Interior
Department of the Treasury
Department of Transportation
Department of Veterans Affairs
Environmental Protection Agency
National Aeronautics and Space Administration
National Archives and Records Administration
National Science Foundation
Nuclear Regulatory Commission
Office of Personnel Management
Small Business Administration
Social Security Administration
U.S. Agency for International Development
U.S. Army Corps of Engineers

O&S Cyber activities by Agency
Department of Agriculture
Department of Commerce
Department of Defense
Department of Education
Department of Energy
Department of Health and Human Services
Department of Homeland Security
Department of Housing and Urban Development
Department of Labor
Department of State
Department of the Interior
Department of the Treasury
Department of Veterans Affairs
Environmental Protection Agency
Nuclear Regulatory Commission
Office of Personnel Management
U.S. Army Corps of Engineers

## Detailed Results: With the Outliers

# Results 1: Development Activities and Factors;

## Agency Specific Values per Factor

Measure for Comparison (alpha = 0.05)	Cost 1: Average % Total Dev	Cost 2: Median % Total Dev*	Cost 3: Average % per Avg FY	Cost 4: Median % per Avg FY**
Pearson's Coefficient (R)	0.0678	0.1614	0.6687	0.2022
P-value for F-Statistic	5.47E-13	3.21E-10	0.1569	1.30E-10
P-value for t-Statistic	0.1359	0.2576	0.2774	0.2402
Std Error (\$M)	0.8867	0.0768	0.223	0.0712
Number of Activities Over-Estimated	29	20	31	20
Average % Overestimated	853%	115%	353%	156%
Number of Activities Under-Estimated	14	19	12	21
Average % Underestimated	37%	50%	55%	51%

\* 4 activities for Cost 2 were exactly equal to the actual cost

\*\* 2 activities for Cost 4 were exactly equal to the actual cost



## Results 2: Development Activities and Factors; Global Values per Factor (All Agencies)

Measure for Comparison (alpha = 0.05)	Cost 1: Average % Total Dev	Cost 2: Median % Total Dev	Cost 3: Average % per Avg FY	Cost 4: Median % per Avg FY**
Pearson's Coefficient (R)	0.0455	0.1327	0.2223	0.2273
P-value for F-Statistic	6.26E-18	0.5503	1.37E-05	0.0214
P-value for t-Statistic	0.0043	0.7451	0.0729	0.6744
Std Error (\$M)	1.5006	0.2302	0.5593	0.1397
Number of Activities Over-Estimated	34	22	31	19
Average % Overestimated	1975%	358%	626%	307%
Number of Activities Under-Estimated	9	21	12	23
Average % Underestimated	40%	62%	36%	59%

*\*\* 1 activity for Cost 4 was exactly equal to the actual cost*

# Results 3: O&S Activities and Factors;

## Agency Specific Values per Factor

Measure for Comparison (alpha = 0.05)	Cost 1: Average % Total O&S	Cost 2: Median % Total O&S	Cost 3: Average % per Avg FY*	Cost 4: Median % per Avg FY
Pearson's Coefficient			0.9571	0.9540
P-value for F-Statistic			0.6089	0.9211
P-value for t-Statistic			0.0937	0.1272
Std Error (\$M)			0.3840	0.4251
Number of Activities Over-Estimated			8	7
Average % Overestimated			111%	81%
Number of Activities Under-Estimated			10	9
Average % Underestimated			35%	42%

*\*2 activities for Cost 3 were exactly equal to the actual cost*

# Results 4: O&S Activities and Factors;

## Global Values per Factor (All Agencies)

Measure for Comparison (alpha = 0.05)	Cost 1: Average % Total O&S	Cost 2: Median % Total O&S	Cost 3: Average % per Avg FY	Cost 4: Median % per Avg FY
Pearson's Coefficient			0.5682	0.1936
P-value for F-Statistic			1.4492E-06	3.454E-11
P-value for t-Statistic			0.3081	0.0757
Std Error (\$M)			0.1157	0.0592
Number of Activities Over-Estimated			13	7
Average % Overestimated			7,045%	2,252%
Number of Activities Under-Estimated			5	11
Average % Underestimated			79%	81%

# Compare to the Factors for % Total Dev \$



- For the Average Factors

- 76% of the activities = 9.77% of Total Dev Costs across 6 categories and 50% of all agencies
- 24% of the activities = 28.3% of Total Dev Costs across 7 categories and 22% of all agencies

- For the Median Factors

- 76% of the activities = 1.98% of Total Dev Costs across 6 categories and 50% of all agencies
- 24% of the activities = 5.19% of Total Dev Costs across 7 categories and 22% of all agencies

Cyber Category	Count by Category All Activities	% of Total Activities	Agencies Represented	% of Agencies	Average by Category (All Agencies)	Median by Category (All Agencies)	High by Category (All Agencies)	Low by Category (All Agencies)
Cyber Progr Management	83	17.33%	14	60.9%	0.88%	0.27%	5.099%	0.000%
Authentication/ Certification	75	15.66%	13	56.5%	5.00%	0.17%	16.284%	0.010%
Cyber Documentation	55	11.48%	11	47.8%	0.34%	0.10%	5.819%	0.000%
Cyber Testing	55	11.48%	10	43.5%	0.86%	0.23%	14.000%	0.004%
Assess Risk/Identify Controls	52	10.86%	9	39.1%	0.76%	0.23%	10.179%	0.000%
SW App Release	45	9.39%	12	52.2%	1.93%	0.99%	15.798%	0.017%
Assess Security (General)	31	6.47%	9	39.1%	0.93%	0.35%	5.487%	0.003%
Cyber Req'ts Analysis	26	5.43%	6	26.1%	0.39%	0.13%	5.012%	0.026%
Architecture/Design	19	3.97%	6	26.1%	1.87%	0.08%	10.586%	0.022%
Contractor Support	18	3.76%	5	21.7%	11.11%	0.84%	56.519%	0.009%
Cyber Training	11	2.30%	4	17.4%	7.74%	2.60%	29.223%	0.023%
Cyber HW Procure	8	1.67%	5	21.7%	5.96%	0.92%	21.619%	0.011%
Cloud Costs/Fees	1	0.21%	1	4.3%	0.29%	0.29%	0.287%	0.287%

## Alternate Results: No Outliers

# Outliers Removed from the Dev Data

Agency	Category	% Tot Dev	Cyber \$M
Department of Homeland Security	Architecture/Design	10.19%	9.14
Office of Personnel Management	Contractor Support	56.52%	26.00
Department of Commerce	Contractor Support	116.09%	17.18
Department of Health and Human Services	Cyber HW Procure	21.62%	6.80
Department of the Treasury	Cyber Progr Management	1.52%	21.92
Department of the Treasury	Cyber Progr Management	1.46%	21.06
Department of Agriculture	Cyber Testing	3.30%	10.00
Department of Veterans Affairs	Cyber Testing	12.03%	8.07

# Outliers Removed from the O&S Data

Agency	Category	% Annual O&S	Cyber \$M
Department of the Treasury	Monitor System/Maintain Controls	43.82%	16.65
Department of Homeland Security	Manage Cyber Operations	8.43%	20.35
Department of Homeland Security	Manage Cyber Operations	8.85%	21.35
Department of Homeland Security	SW Maint Release	27.69%	21.81
Department of Homeland Security	Manage Cyber Operations	17.34%	41.83

# Results 1: Development Activities and Factors;

## Agency Specific Values per Factor

Measure for Comparison (alpha = 0.05)	Cost 1: Average % Total Dev	Cost 2: Median % Total Dev*	Cost 3: Average % per FY	Cost 4: Median % per FY**
Pearson's Coefficient (R)	0.0692	0.4939	0.1405	0.1369
P-value for F-Statistic	6.62e-13	1.253e-09	6.168e-50	4.638E-45
P-value for t-Statistic	0.1398	0.2298	0.0892	0.1749
Std Error (\$M)	0.8820	0.0801	13.5639	7.3350
Number of Activities Over-Estimated	29	29	39	35
Average % Overestimated	838%	104%	3831%	2161%
Number of Activities Under-Estimated	14	19	4	8
Average % Underestimated	37%	48%	33%	53%

\* 4 activities for Cost 2 were exactly equal to the actual cost

\*\* 2 activities for Cost 4 were exactly equal to the actual cost



## Results 2: Development Activities and Factors; Global Values per Factor (All Agencies)

Measure for Comparison (alpha = 0.05)	Cost 1: Average % Total Dev	Cost 2: Median % Total Dev	Cost 3: Average % per FY	Cost 4: Median % per FY**
Pearson's Coefficient (R)	0.1309	0.1360	0.0896	0.0322
P-value for F-Statistic	1.39e-13	0.6327	6.345E-30	0.0002
P-value for t-Statistic	0.0373	0.8165	0.0037	0.0336
Std Error (\$M)	1.091	0.2260	5.1779	0.5215
Number of Activities Over-Estimated	33	22	40	32
Average % Overestimated	926%	333%	3898%	1453%
Number of Activities Under-Estimated	10	21	3	11
Average % Underestimated	39%	63%	48%	73%

*\*\* 1 activity for Cost 4 was exactly equal to the actual cost*

# Results 3: O&S Activities and Factors;

## Agency Specific Values per Factor

Measure for Comparison (alpha = 0.05)0.9540	Cost 1: Average % Total O&S	Cost 2: Median % Total O&S	Cost 3: Average % per FY*	Cost 4: Median % per FY
Pearson's Coefficient	N/A	N/A	0.9571	0.9540
P-value for F-Statistic	No	No	0.6089	0.9211
P-value for t-Statistic	Factors	Factors	0.0937	0.1272
Std Error (\$M)	For	For	0.3840	0.4251
Number of Activities Over-Estimated	%	%	8	7
Average % Overestimated	Total	Total	11%	81%
Number of Activities Under-Estimated	O&S	O&S	10	9
Average % Underestimated	Spending	Spending	35%	42%

*\*2 activities for Cost 3 were exactly equal to the actual cost*

# Results 4: O&S Activities and Factors;

## Global Values per Factor (All Agencies)

Measure for Comparison (alpha = 0.05)	Cost 1: Average % Total O&S	Cost 2: Median % Total O&S	Cost 3: Average % per FY	Cost 4: Median % per FY
Pearson's Coefficient	N/A	N/A	0.6936	0.1992
P-value for F-Statistic	No	No	5.30e-7	3.129e-11
P-value for t-Statistic	Factors	Factors	0.1728	0.0743
Std Error (\$M)	For	For	0.1083	0.0588
Number of Activities Over-Estimated	%	%	12	7
Average % Overestimated	Total	Total	6696%	2177%
Number of Activities Under-Estimated	O&S	O&S	6	11
Average % Underestimated	Spending	Spending	74%	81%

# Compare to Factors for the % Avg Yearly Dev \$

- **For the Average Factors** (Lower Avg; Contractor Support no longer a “spike”)
  - **77% of the activities** =22.75% of Avg Yearly Dev \$ across 6 categories and 50% of all agencies
  - 23% of the activities =18.51% of Avg Yearly Dev \$ across 7 categories and 22% of all agencies
- **For the Median Factors** (Minimal change to Median; Validates skew in the DB)
  - **76% of the activities** = 6.23% of Avg Yearly Dev \$ across 6 categories and 50% of all agencies
  - 24% of the activities =10.49% of Avg Yearly Dev \$ across 7 categories and 22% of all agencies

Cyber Category	Count by Category All Activities	% of Total Activities	Agencies Represented	% of Agencies	Average by Category (All Agencies)	Median by Category (All Agencies)	High by Category (All Agencies)	Low by Category (All Agencies)
Cyber Progr Management	81	17.27%	14	60.9%	2.17%	0.35%	39.253%	0.035%
Authentication/ Certification	75	15.99%	13	56.5%	3.62%	1.68%	20.667%	0.008%
Cyber Documentation	55	11.73%	11	47.8%	3.41%	1.43%	52.900%	0.047%
Cyber Testing	53	11.30%	10	43.5%	6.38%	1.37%	43.457%	0.048%
Assess Risk/Identify Controls	52	11.09%	9	39.1%	4.82%	0.92%	70.211%	0.011%
SW App Release	45	9.59%	12	52.2%	2.36%	0.49%	12.709%	0.017%
Assess Security (General)	31	6.61%	9	39.1%	2.98%	1.53%	14.892%	0.324%
Cyber Req'ts Analysis	26	5.54%	6	26.1%	2.20%	1.19%	11.415%	0.223%
Architecture/Design	17	3.62%	6	26.1%	1.39%	1.00%	6.484%	0.090%
Contractor Support	16	3.41%	3	13.0%	7.84%	4.11%	26.312%	0.016%
Cyber Training	11	2.35%	4	17.4%	1.08%	0.21%	5.290%	0.182%
Cyber HW Procure	6	1.28%	4	17.4%	0.84%	0.26%	2.291%	0.159%
Cloud Costs/Fees	1	0.21%	1	4.3%	2.17%	2.17%	2.174%	2.174%

# Final Slide

